

Amendments to the Specification:

Please make the following amendments to the specification.

Page 9, Line 16 – Page 10, Line 9:

FIG. 2 is a graph showing the energy efficiency as a function of the molar ratio of CH₄ to molecular oxygen for the generation of hydrogen from methane and water. As shown in FIG. 2, the autothermal conversion of methane and water to hydrogen is most efficient when the reaction is conducted with a molar ratio of molecular oxygen to fuel near the thermoneutral x_0 value. As shown in FIG. 2, the efficiency of the process remains quite high when the molar ratio of O₂ to CH₄ is less than x_0 , but the efficiency drops off rapidly when the molar ratio of O₂ to CH₄ increases over x_0 . For the purposes of this discussion, efficiency is defined as the lower heating value of the product hydrogen from the reformer, as a percentage of the lower heating value of the fuel ~~feed~~entering the reformer. Although the process is most efficient when the molar ratio of O₂ to the fuel is x_0 , to achieve fast enough reaction rates and to obtain high hydrogen concentrations in the product gas, it is preferable to operate the reactor at a temperature of from about 100°C to about 900°C. In another preferred process, the reactor is maintained at a temperature of from about 400°C to about 700°C. In still other preferred processes, the reactor is maintained at a temperature of about 700°C. Preferred fuel processors for use in the method of the present invention include a reforming portion in which the mixture of oxygen, fuel, and water are converted to a H₂ rich gas stream. In preferred processes according to the present invention, the H₂ rich gas exits the reforming portion at a temperature of from at or about 100°C to at or about 900°C and more preferably from at or about 400°C to at or about 700°C. The preferred operating temperatures are achieved by increasing the air to fuel ratio slightly above the thermoneutral point.

Page 10, Lines 10-22:

As noted above, when the molar ratio of O_2 to fuel is greater than x_0 , the reaction is exothermic such that the desired temperature may be achieved. The lower operating temperatures of the fuel processor that are obtained using the method of the present invention result in less carbon monoxide being produced in the reforming portion of the fuel processor. Thus, converting the mixture of oxygen, fuel, and water under the conditions described herein less carbon monoxide is produced and consequently, less carbon monoxide needs to be water-gas-shifted to produce carbon dioxide and H_2 . This is one significant advantages offered when the method of the present invention is used. Table 1 shows experimental examples for the conversion of various fuels at specified O_2 to fuel molar ratios (x); water to fuel molar ratios ($2n - 2x - p$) [the water/fuel molar ratios used in the experiment and noted in Table 1 are greater than the calculated value of $2n - 2x - p$]; and reactor temperatures. Table 1 also provides data regarding the composition of the hydrogen rich gas produced by the process as percentages on a dry nitrogen-free basis.

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As noted above, the invention provides a method for generating hydrogen rich gas and includes supplying a mixture of O_2 , fuel, and water to a fuel processor and converting the mixture to the hydrogen rich gas stream. A fuel processor such as those disclosed in the United States Patent No. 6,713,040 ~~Application entitled “Fuel Processor and Method for Generating Hydrogen for Fuel Cells”~~, the entire disclosure of which is hereby incorporated by reference, ~~by the inventors S. Ahmed, S. H. W. Lee, J. D. Carter, and M. Krumpelt and filed simultaneously with the present invention,~~ may be used in conjunction with the present invention. Preferably, the conversion of the mixture of molecular oxygen, fuel, and water to the H_2 rich gas stream includes contacting the mixture with a catalyst in the fuel processor to produce the H_2 rich gas stream. As described above, the molar ratio of O_2 to fuel and the molar ratio of water to fuel are both dependent on the determination of the value of x_0 for a particular fuel. The value of x_0 for a

particular fuel of formula $C_nH_mO_p$ may be determined using the equation $0.312n - 0.5p + 0.5(\Delta H_{f, \text{fuel}}/\Delta H_{f, \text{water}})$ where $\Delta H_{f, \text{fuel}}$ is the heat of formation of the fuel and $\Delta H_{f, \text{water}}$ is the heat of formation of water.

Page 14, Legend of Table 2:

Table 2. Calculated thermoneutral O_2 /fuel ratios (x_0) and maximum theoretical efficiencies at x_0 for various fuels. The value for x_0 is based upon the heat of formation for liquid water.

Page 16, line 19 - page 17, line 3

Various catalysts may be used in the method of the present invention. Examples of particularly suitable catalysts for use in autothermal reforming are set forth in United States Patent No. 5,929,286, the entire disclosure of which is incorporated herein. Thus, in a preferred method according to the invention, the catalyst includes a transition metal and an oxide-ion conducting portion, and the mixture of molecular oxygen, fuel, and water is contacted with the catalyst at a temperature of 400°C or greater. Preferably, the transition metal of the catalyst includes a metal selected from platinum, palladium, ruthenium, rhodium, iridium, iron, cobalt, nickel, copper, silver, gold, and mixtures of these and the oxide-ion conducting portion of the catalyst is selected ~~from~~from a ceramic oxide from the group crystallizing in the fluorite structure or ~~LaBaO₃~~LaGaO₃ or mixtures of these. In other preferred methods according to the invention, the catalyst is an autothermally reforming catalyst that operates at a temperature ranging from about 100°C to about 700°C.

Page 17, Line 24 – Page 18, Line 13:

The reaction temperature plays an important role in the amount of carbon monoxide emerging from a water-gas-shift reactor. The method of the present invention can thus be used to modify the temperature of gas streams that will be directed, after reforming, to a water-gas-shift reactor with a particular catalyst. For example, the molar ratio of molecular oxygen to fuel may be adjusted to produce a hotter or cooler stream that matches the preferred temperature range over which the water-gas shift catalyst functions. FIG. 3 is a graph showing the percentage of carbon monoxide contained in a product stream after emerging from a water-gas-shift reactor loaded with a catalyst (0.8 wt. % platinum on gadolinium doped ceria $(\text{Pt/Ce}_{0.8}\text{Gd}_{0.2}\text{O}_{1.95})$) as a function of reaction temperature. The reactant composition prior to contacting the water-gas-shift reactor on a dry basis was 10.5% CO, 31.2% N₂, 1.9% CH₄, and 43.4% H₂. The H₂O/CO molar ratio in the reactant stream was 3.5. As shown in FIG. 3, for this particular platinum on gadolinium doped ceria catalyst stream, the preferred reaction temperature ranges from about 200°C to about 300°C. More preferably, the reaction temperature ranges from about 210°C to about 280°C and still more preferably ranges from about 225°C to about 270°C. Most preferably, the reaction temperature using the platinum on gadolinium doped ceria water-gas-shift catalyst ranges from about 225°C to about 260°C and is about 240°C.